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Snow accumulation submodel: how to estimate the phase of precipitations and the snow correction factor?

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A snow model is an important component of a snow-dominated watershed hydrology model since most of winter precipitation are stored in the snowpack and then released afterwards. The two basic components of these snow models are the snow accumulation and melt routines.

Whatever the approach and the scale used to model snowmelt, accumulation modelling implies i) an estimate of meteorological inputs (precipitations, temperatures at least), ii) a model to separate the precipitation into snow and rain and iii) an estimate of gauge catch deficiency due to wind effect during snowfall. The process of redistribution of snow over the landscape could also be taking into account, especially for spatial model, through snow distribution patterns.

EDF (French electricity provider) has a significant network of snow stations measuring daily snow water equivalent (SWE). 36 Cosmic-Ray Snow Sensors, installed in the French mountainous regions, provides since about 10 years a real-time measurement of the snow water equivalent by measuring the absorption of the cosmic-ray neutrons by the snowpack water. Hourly temperatures are also gathered at each station. A daily precipitation re-analysis database is available and provides an objective precipitation input for snow model over the study area [Gottardi et al, 2009].

Based on these data, the aim of this work is first to investigate different precipitation phase separation schemes, all based on ground surface temperatures and threshold(s). - One single temperature threshold based on daily air temperature or on daily minimum and maximum temperatures - Two air temperature thresholds (one for all snow and one for all rain) with i) a linear increase of rain fraction with air temperature between the thresholds or ii) an S-shaped transition curve. Regional variability of surface air temperature thresholds, implications in snow quantity and rain-on-snow events are also investigated. Calibration and validation of the models are based on performance criteria that represent the occurrence and the amount of misclassified precipitation.

The estimation of the snow correction factor, to evaluate the deficit of estimated precipitation, is carried out in a second part. Because of the wide variability of snow correction factors from storm to storm (SCF values can be as high as 2.2, Kongoli and Band, 2000), annual snow correction factors were computed using cumulative solid precipitation data from Cosmic-Ray Snow Sensors for each site. Mean snow correction factor are then determined by calibration of linear regression curves. Regional and inter-annual variability are investigated.

Kongoli, C. E. & Bland, W. L. Long-term snow depth simulations using a modified atmosphere-land exchange model. Agricultural and Forest Meteorology, 2000, 104, 273 - 287
Gottardi, F., Obled, C.. Statistical reanalysis of precipitation fields over French mountains based on ground network data and weather pattern. Journal of Hydrology. (accepted)